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GLACIOLOGY IN EASTERN QUEEN MAUD LAND

PRELIMINARY REPORT
THIRD BELGIAN ANTARCTIC EXPEDITION 1960

W. DE BREUCK

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WETENSCHAPPEN

JAARGANG XXIII

Nr. 6

1961

Paleis der Academiën — Hertogsstraat, 1
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Mededeling aangeboden door Prof. R. *Tavernier ter zitting van* 14 *october* 1961.

W. De Breuck (*) : *Glaciology in Eastern Queen Maud Land. (Preliminary report—Third Belgian Antarctic Expedition* 1960).

Abstract

During the year 1960 glaciological studies were carried out, both at King Baudouin Station (70°26' S - 24°19' E) on the ice shelf of Princess Ragnhild Coast and during excursions on the continental foreland and in the Sör-Rondane Mountains. Samples of snow and of ice for isotope and chemical analyses in Belgium were collected from these different areas.

At the base, accumulation and ram hardness were recorded monthly. An attempt was made to study snowdrift accumulation. Observations on the deeper firn were made along a vertical 16 m deep profile. During the summer of 1960-1961 a deep drilling down to 115,7 m was successfully carried out by the summer party, lead by Dr. E. Picciotto.

During the summer excursions by sledge in November and December 1960 pits of approximately 1 m were dug to investigate temperature, density and stratigraphy. Total accumulation for 1960 was measured on the stakes set up in February and March 1960.

INTRODUCTION

King Baudouin Station (70°26' S - 24°19' E, J. Loodts, 1960) is situated at about 12 km from the sea, on the ice shelf on the Princess Ragnhild Coast. It was built in December 1957 and was occupied until January 1961 (Fig. 1).

Access to the 35 m high ice cliff is facilitated by a large inlet, the Breid Bay, subdivided in several smaller bays (Glacier Bay, King Leopold III Bay, Polarhav Bay). The landward margin of the shelf is assumed to be formed by a hill, attaining 350 m, a few km south of the station.

The Sör-Rondane Mountains are 200 km inland from the coast. Only a few nunataks point through the snow cover of the continental foreland. One of these, the Mount Romnoes, 1500 m high, is situated at about 120 km south of the station. The Sör-Rondane Mountains stretch out from 71°40' S to 72°20' S and from 21°30' E tot 27°30' E about 200

(*) Laboratorium voor Fysische Aardrijkskunde, Rijksuniversiteit, Gent. Lid van de derde Zuidpoolexpeditie 1960.

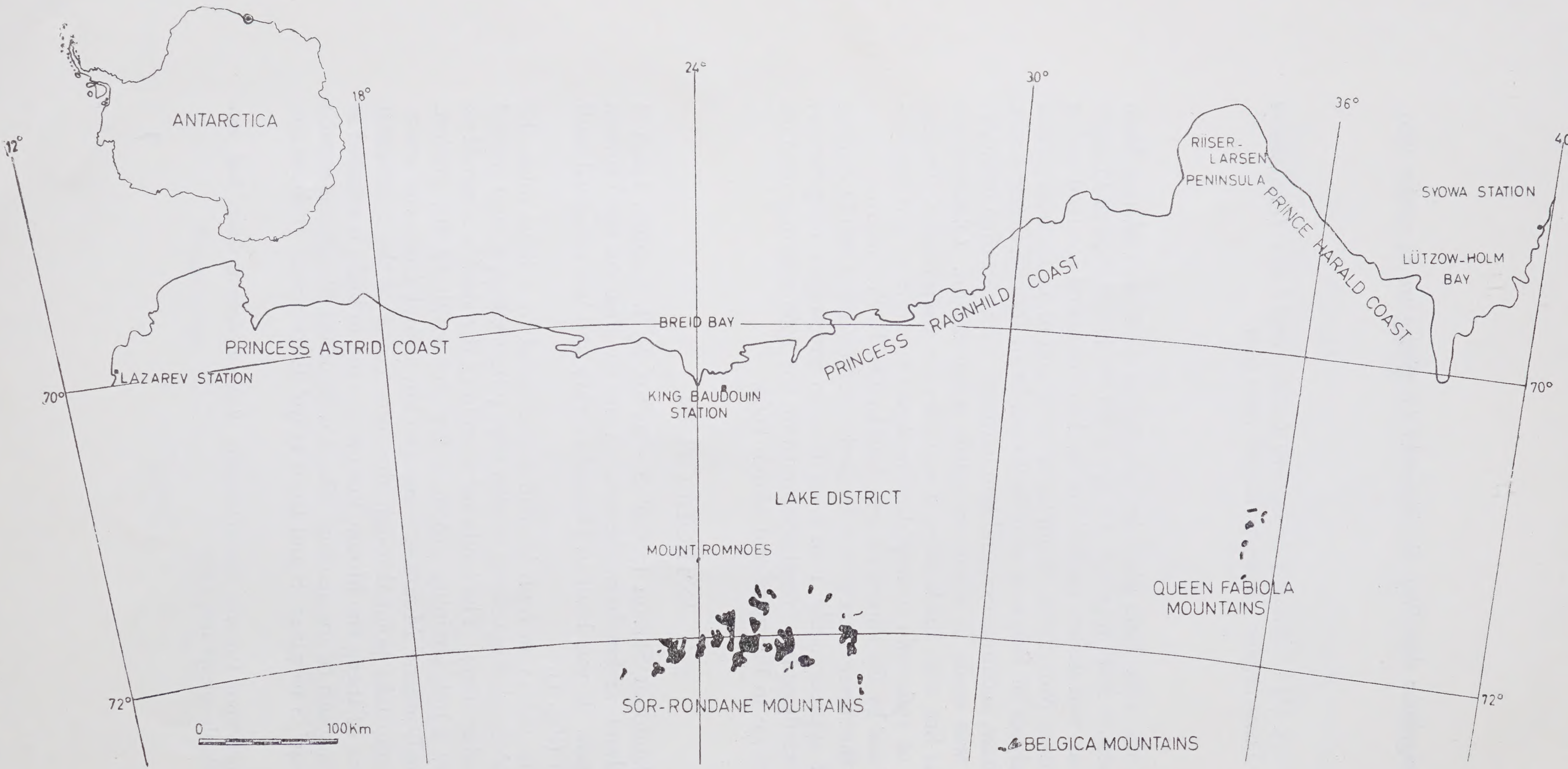

FIG. 1. Eastern Queen Maud Land. Compiled from different charts (Institut Géographique Militaire, American Geographical Society, Norsk Polarinstitutt, Flight report B.A.E. 1960).
Terre de la Reine Maud, partie orientale; d'après des données des cartes de l'Institut Géographique Militaire, de l'American Geographical Society, du Norsk Polarinstitutt et le rapport de vol de l'E.A.B. 1960.
Koningin-Maudland, oostelijk gedeelte, volgens kaarten van het Militair Geografisch Instituut, de American Geographical Society, het Norsk Polarinstitutt en het vluchtrapport van de B.Z.E. 1960.

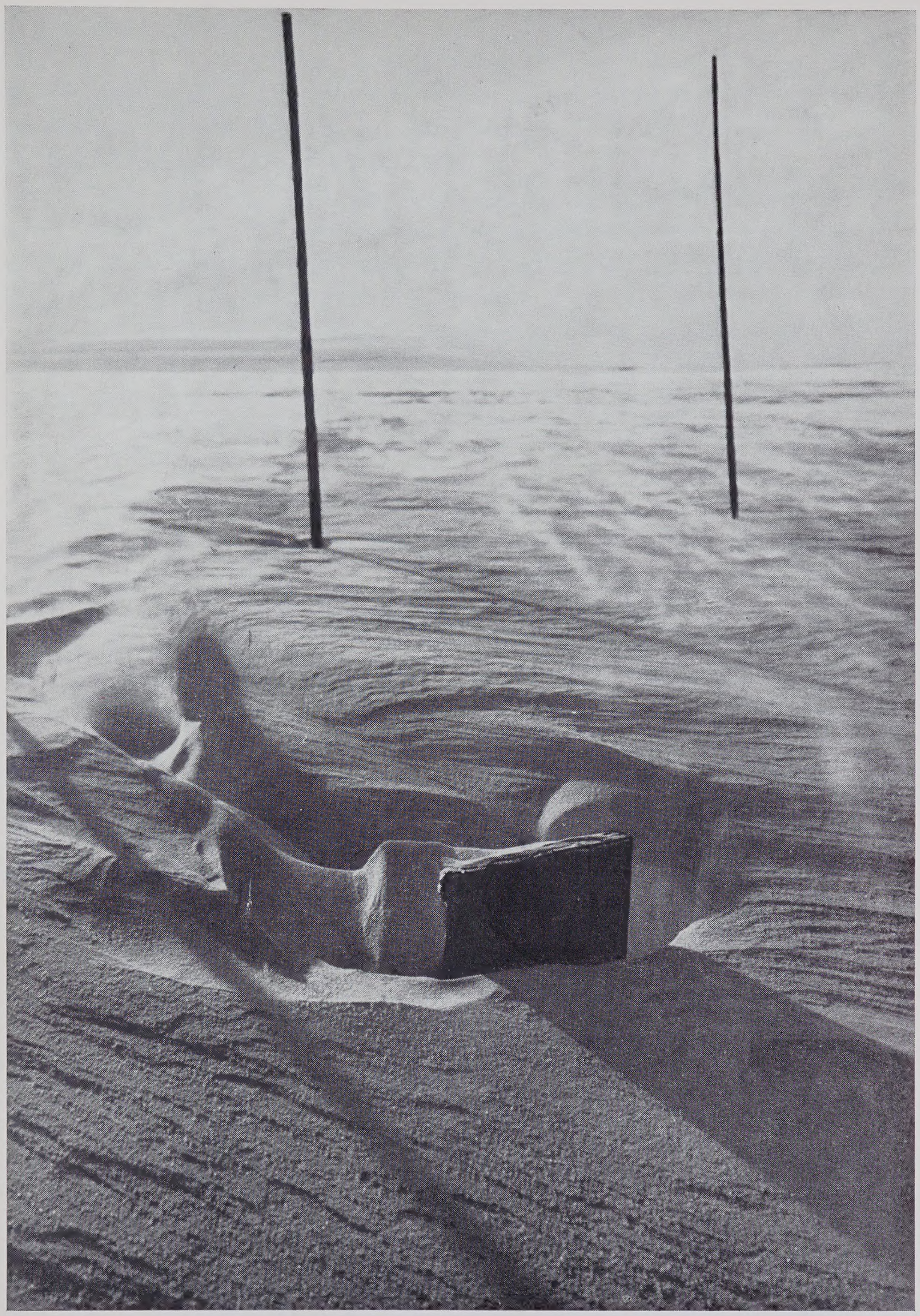

Photo 1 (L. Goossens)

Accumulation caused by snowdrift round a panel, 50 cm × 50 cm, placed perpendicularly to the direction of the prevailing winds. The raise of the snowcover was measured on stakes.

Accumulation causée par le chasse-neige aux abords d'un paneau 50 cm × 50 cm, placé perpendiculairement à la direction des vents dominants. L'augmentation du niveau de la couverture neigeuse était mesurée sur des jalons.

Akkumulatie veroorzaakt door de sneeuwdrift rond een paneel van 50 cm × 50 cm, loodrecht op de richting van de overheersende winden aangebracht. Het stijgen van het sneeuwoppervlak werd op bakens afgelezen.

km in length and 100 km in width. Most of the summits range between 2000 and 3000 m, the highest reaching 3450 m. The altitude of the glaciers varies between 1500 and 3000 m.

At about 450 km south-west of the station lies a smaller range, the Belgica Mountains. It is about 10 km wide (from 72°30' S to 72°40' S) and 20 km long (from 30°30' E to 31°30' E). Summits are about 2300 m high. The surrounding snowcover is at 2000 m.

Behind the mountains starts the immense polar plateau.

INVESTIGATIONS AT THE BASE

ACCUMULATION AND DENSITY

At about 2 km south of the station out of the zone influenced by the base, a spot was chosen for the accumulation studies. For this purpose a cross of 2 km was set out; 11 aluminium stakes, each with a length of 2,50 m were set up every 200 m in a roughly east-west direction; another 11 in a north-south direction. Near the middle of the cross a 20 m square of four stakes, linked together by a string, was erected so as to be able to make density measurements. From April 1960 to January 1961 stakes were measured monthly. Snow heights are recorded in Fig. 2.

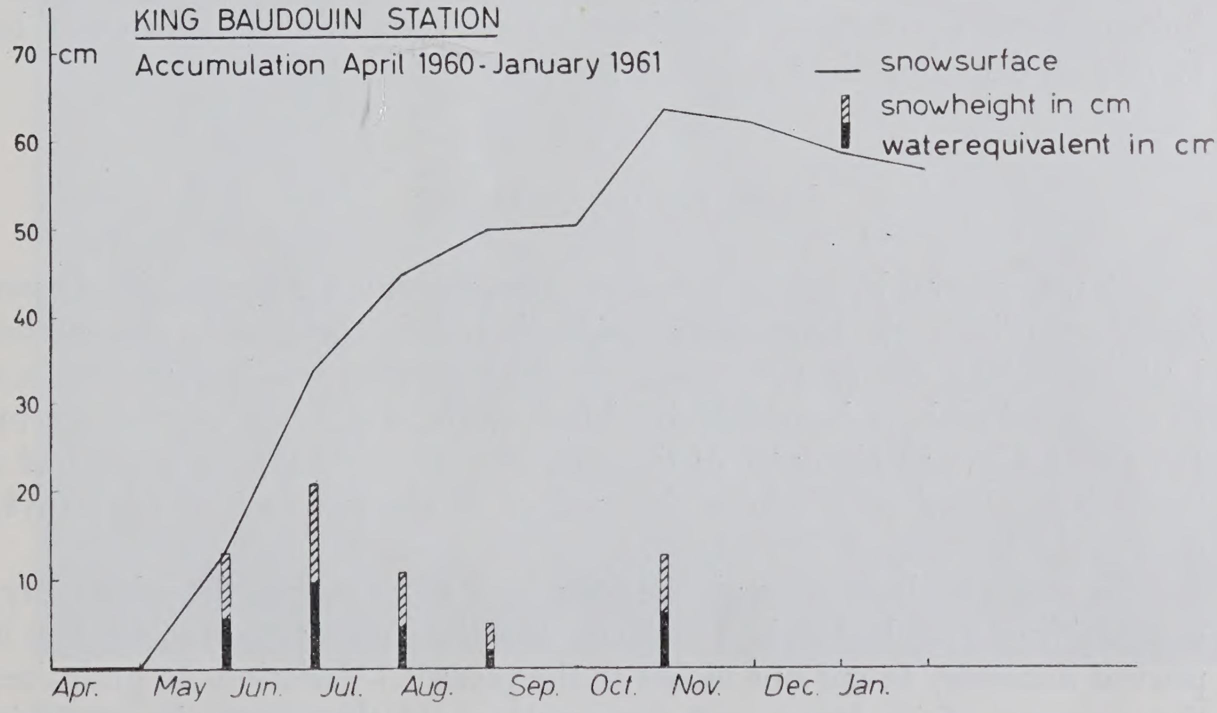

FIG. 2. Accumulation at King Baudouin Station from April 4, 1960 to January 30, 1961. L'accumulation du 4 avril 1960 au 30 janvier 1961 à la base Roi Baudouin. Akkumulatie nabij de Koning-Boudewijnbasis, van 4 april 1960 tot 30 januari 1961.

Most of the amount was accumulated in March, May and June.

For the whole of the period preceding April 1960 an accumulation of 33 cm of snow was deduced from a boring. For the year 1960 the total accumulation should thus be 45,5 cm water equivalent; this is a little higher than the average of the six preceding years, which is about 40 cm.

Density measurements were made in a pit near the square at the end of December (Fig. 3).

Freshly precipitated snow was collected. The crystal form was noted. Photographs were made by means of a microscope.

Snowdrift accumulation

Panels of 25 by 25 and 50 by 50 cm were put perpendicularly to the prevailing wind direction (Photo 1). Stakes were planted every five or ten metres perpendicularly to the panel and one or two rows of stakes were lined up parallel to the obstruction. Accumulation on the windward side was limited to a few metres, whereas the influence of the obstruction on the lee side stretched out for several tens of metres behind. The scoop formed in front of the panel was maintained until the snowsurface reached a critical height (about 3/4 of the height of the panel) whereafter it collapsed.

Panels and cubes of greater dimensions (up to 2 m) may yield more information. To complete the observations, aerial photographs could be of help in depicting the pattern of the snowdrifts.

Deep pit observations

A pit, cut out by an electric snow saw, provided access to the deeper firnlayers (Photo 2). Dimensions were about one metre wide, two metres high and with a dip of 45°. The excavated material was brought up in a sledge, worked by a hand winch. Most of the work was carried out by I. Van de Can, glaciologist of the second expedition (*). The pit had a vertical depth of 16 m under the surface of the summer of 1957-1958, date of the first expedition's arrival.

In order to have enough working and store room, the laboratory, at a depth of 7 m, had to be enlarged. For the investigation of the firn it proved necessary to cut out niches in the pitwall. Variations in grainsize, the presence of ice layers and icy crusts could thus easily be made in

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(*) The results of his work are to be published in the scientific reports of the second Belgian Antarctic Expedition.

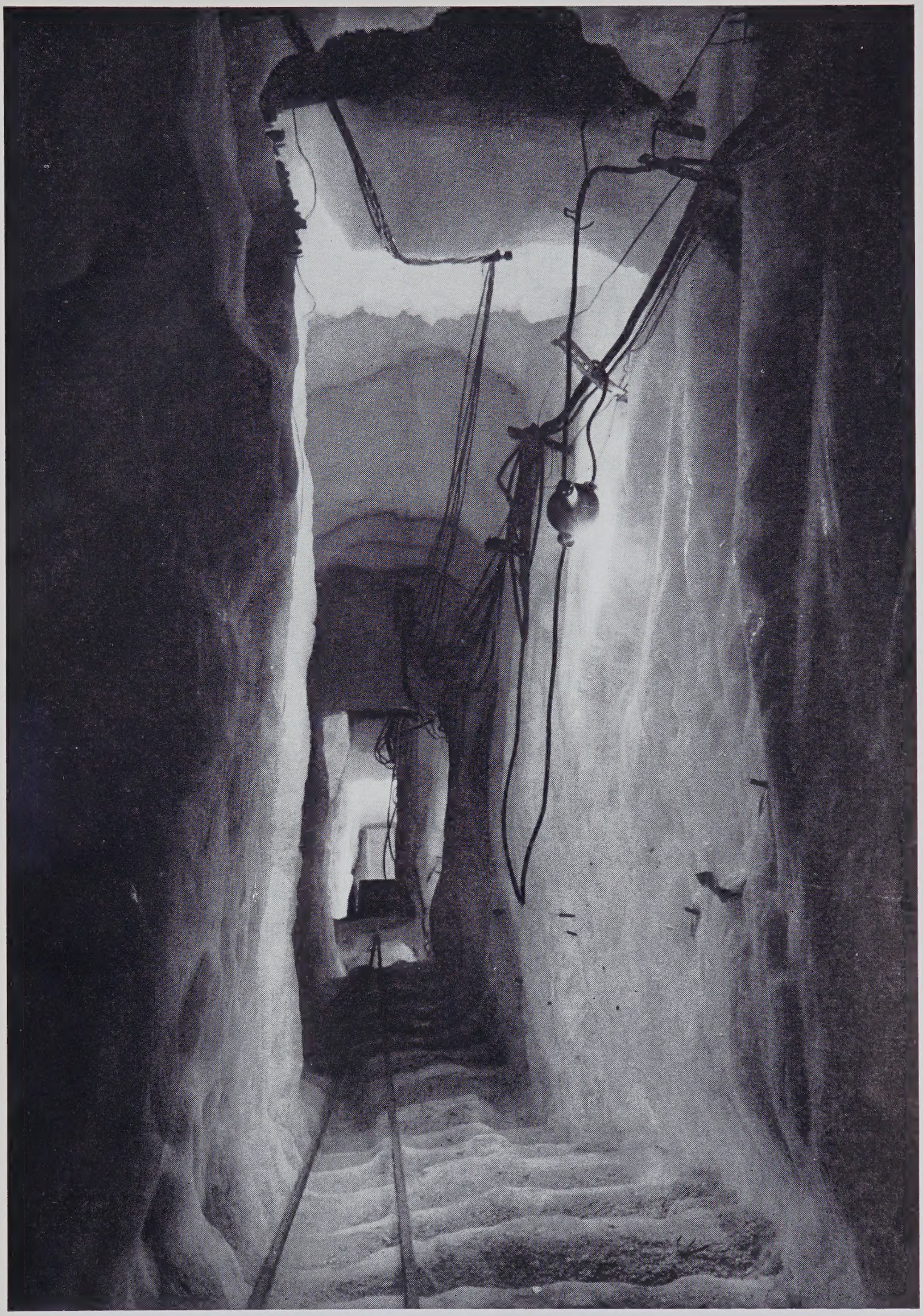

Photo 2 (L. Goossens)

A pit, with a vertical depth of 16 m was dug to investigate the deeper firn and ice layers. Excavated snow was brought up in a sledge, worked by a hand winch.

Un puits d'une profondeur verticale de 16 m donnait accès aux couches de névé et de glace profondes. La neige était évacuée dans un traîneau, remonté par un treuil à main.

Een put van 16 m diepte verleende toegang tot de diepere firn- en ijslagen. De losgehakte firn werd bovengehaald in een slede door middel van een met de hand aangedreven windas.

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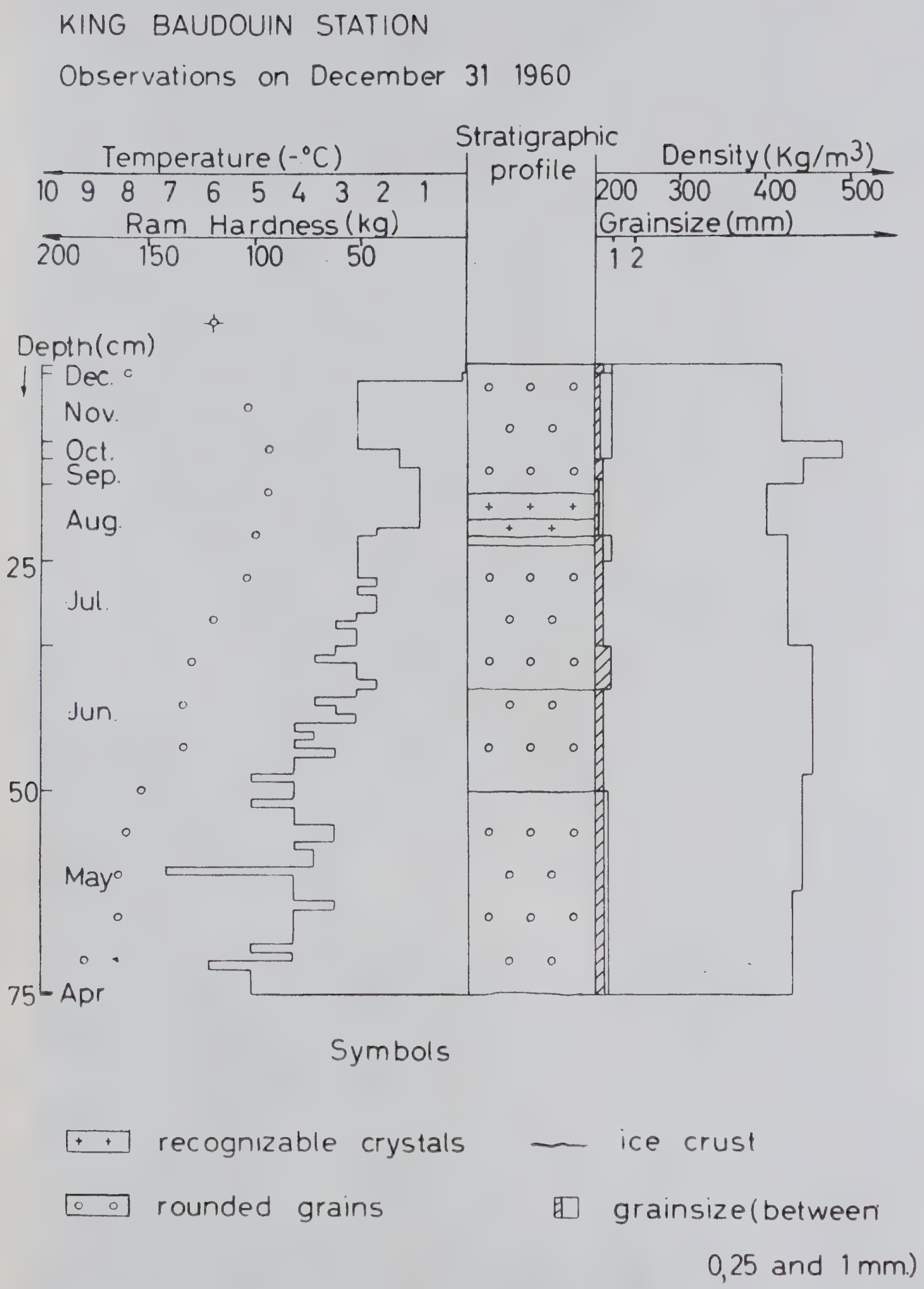

FIG. 3. Snowprofile at King Baudouin Station on December 31, 1960.
Profil de neige à la base Roi Baudouin, relevé le 31 décembre 1960.
Sneeuwprofiel nabij de Koning-Boudewijnbasis op 31 december 1960.

transmitted light. The niches were about 2 m high, 0,5 m wide and 0,5 m deep, each overlapping the preceding and the following one. A block 10 cm thick was cut out of every niche. Photographs were taken in transmitted light (Photo 3) whereafter every layer was sawn out, so as to obtain a sample of every deposit for isotope and chemical study in Belgium. The samples were melted at a temperature lower than + 18 °C and then stored at —10 °C in polyethylene bottles.

Distinction of the annual accumulation is based mainly on the alternation of coarse grain summer layers with ice formations and fine grain winter deposits (W. SCHYTT, 1958). The grainsize was estimated on a millimetred scale plate through a magnifying glass. Intense ice formation is observed between 6 and 9 m corresponding to the period running from 1945 to 1949. It is difficult to distinguish the years in that section of the profile as there are no fine grain deposits. With some restriction and as a first approximation the mean accumulation between 1938 and 1957 comes to 46,5 cm.

Density measurements were made on cores provided with the Sipre auger. For this purpose several drillings were carried out to verify the accuracy of the data, as ice often occurs as lenses attaining a thickness of several centimetres. The depth-density curve is similar to those found by earlier expeditions (Maudheim, Little America V, Byrd) taken into account that the level of the summer 1957-1958 is about 4 m under the snow surface (Fig. 4). The abnormal densities between 6 and 10 m are due

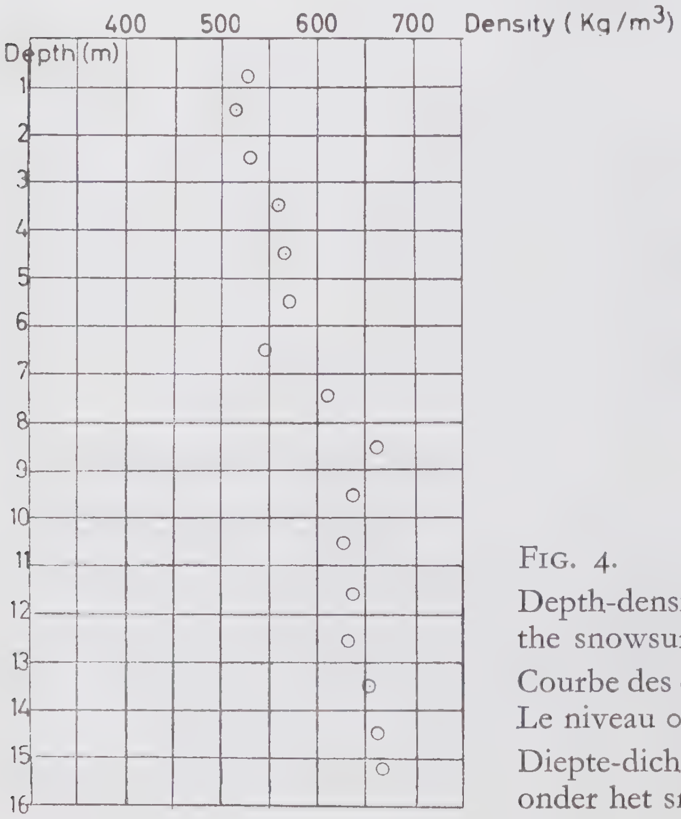

FIG. 4.

Depth-density-curve. The 0 is at 4 m under the snowsurface.

Courbe des densités en fonction de la profondeur. Le niveau 0 est à 4 m sous la surface.

Diepte-dichtheidskurve. Het nulniveau is op 4 m onder het sneeuwoppervlak.

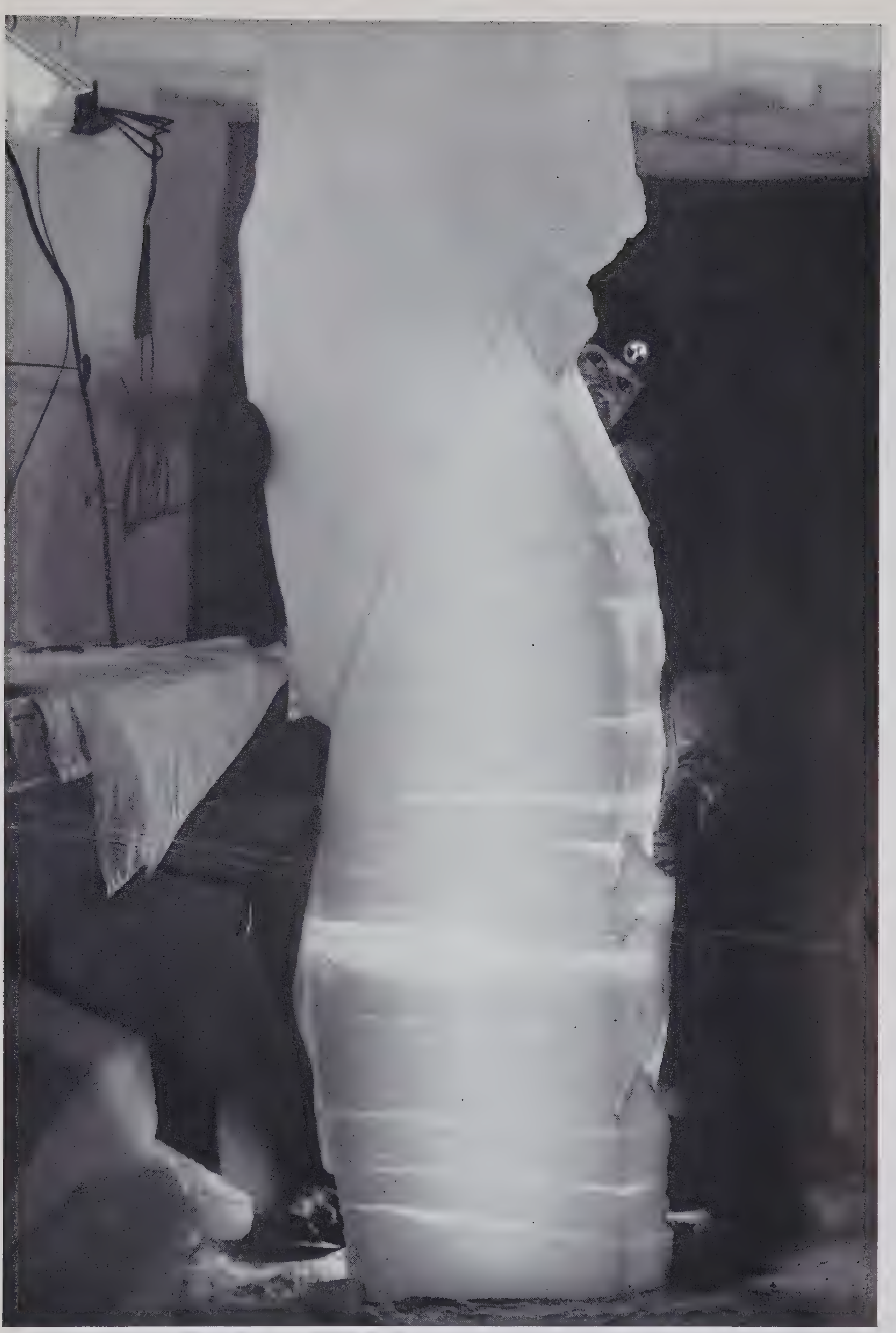

Photo 3 (L. Goossens)

Blocks, 10 cm thick, 20 cm wide and variating in heigth, were cut out of every niche in the pitwall. Photographs were made in transmitted light. Layers of coarse grain firn with ice lenses (under) indicate summer conditions, while fine grain firn (above) correspond to winter deposits.

Des blocs d'une épaisseur de 10 cm, d'une largeur de 20 cm et d'une hauteur variable, étaient photographiés par transparence. Les couches de gros névé avec des lentilles de glace (bas) indiquent des influences de l'été, tandis que les couches à grain fin (haut) correspondent à des dépôts d'hiver.

Blokken van 10 cm dik, 20 cm breed en wisselend in hoogte, werden gefotografeerd in doorvallend licht. De lagen van grove firn met ijslenzen (onder) duiden op zomerinvloeden, terwijl de fijnkorrelige lagen (boven) overeenstemmen met winterafzettingen.

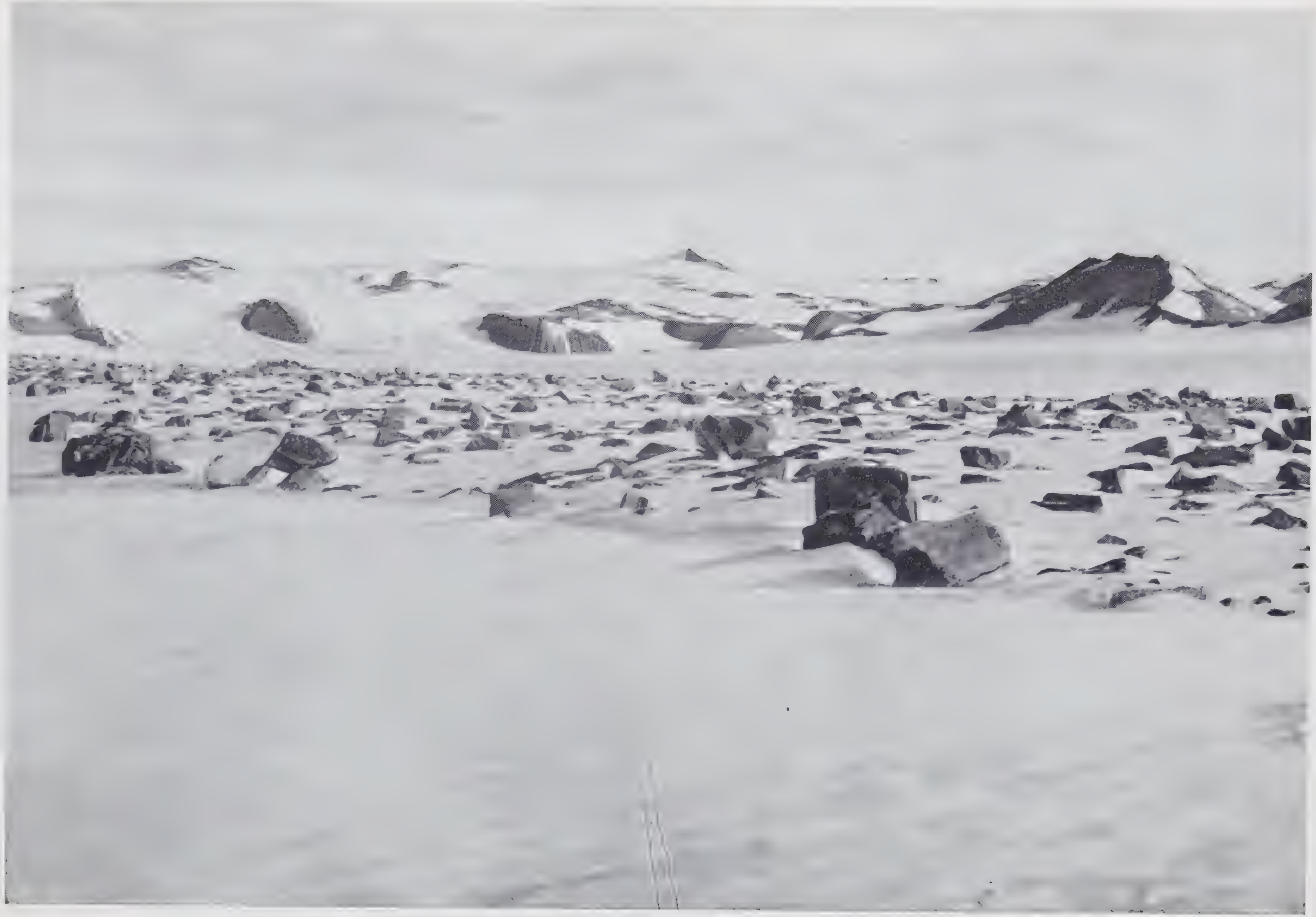

Photo 4 (L. Goossens) Sör-Rondane Mountains. Gillock Glacier from the north.
Les Monts Sör-Rondane. Glacier de Gillock du nord.
Sör-Rondanebergen. Gillockgletsjer vanuit het noorden.

to the presence of coarse grain layers and ice formations. Temperature measurements proved inaccurate. Weston dial thermometers, thermocouples and thermistors indicated the same anomalies. A general decrease with the depth was noticed but the influence of the base was still perceptible.

Deep drilling at King Baudouin Station

The glaciological summer party of 1961 under the direction of Dr. E. Picciotto carried out a deep-drilling which attained the level of 115,7 m.

Stratigraphy and density down to 43 m were recorded at the site. Core recovery was almost 100 % to 80 m and 55 % from 80 to 115 m.

The principal aim of the drilling was to obtain a complete set of samples for chemical and isotope analyses, since earlier investigations were very promising.

Investigations between the station and the mountain area

On the continental foreland the rate of accumulation was measured. From King Baudouin Station to Mount Romnoes, at 118 km to the South, eight rows of five bamboos each at a distance of 250 m, were set up perpendiculary to the line Base-Romnoes. This was carried out by aircraft on February 11 and 12, 1960. A distance of 15 km separated the first seven stations, the distance between 7 and 8 being only 6 km.

Only the first set of stakes could be recovered at the end of September. An accumulation of 95 cm of snow was recorded on September 28.

Between December 21 and 27, 1960, all the stations were visited by vehicle. Pits were dug along the whole profile. Accumulation decreased to the South as can be seen from Fig. 5.

Ram hardness, temperature, density and stratigraphy were recorded.

Investigation in the Sör-Rondane Mountains

After the Winter of 1960 the accumulation stakes, set up on the Gillock, the Ellis, the Jennings and the Gjel Glacier, were measured. On the Gillock and the Ellis Glacier a general ablation was noted. Only the western sides of the glaciers showed a slight accumulation, carried by the eastern winds. High and hard sastrugis (50 cm and more) made it impossible for the aircrafts to land. The hard top surface of the sastrugis seemed to correspond with the surface of the snow of March 1960, since the strings around the bamboos were scarcely covered or even uncovered.

On the Jennings Glacier an accumulation of 10 cm of snow, 3,8 cm of water, was observed at the height of Brattnipane. On the Gjel Glacier between Austkampane and Brattnipane a mean snow accumulation of 45 cm was noticed.

Everywhere the glare ice areas had considerably increased. Meltwater was often seen in ice-covered morainic zones.

Density, temperature and stratigraphy were also recorded in pits dug near the stakes.

Movement of different glaciers was observed by the surveyor of the expedition, K. Blaiklock.

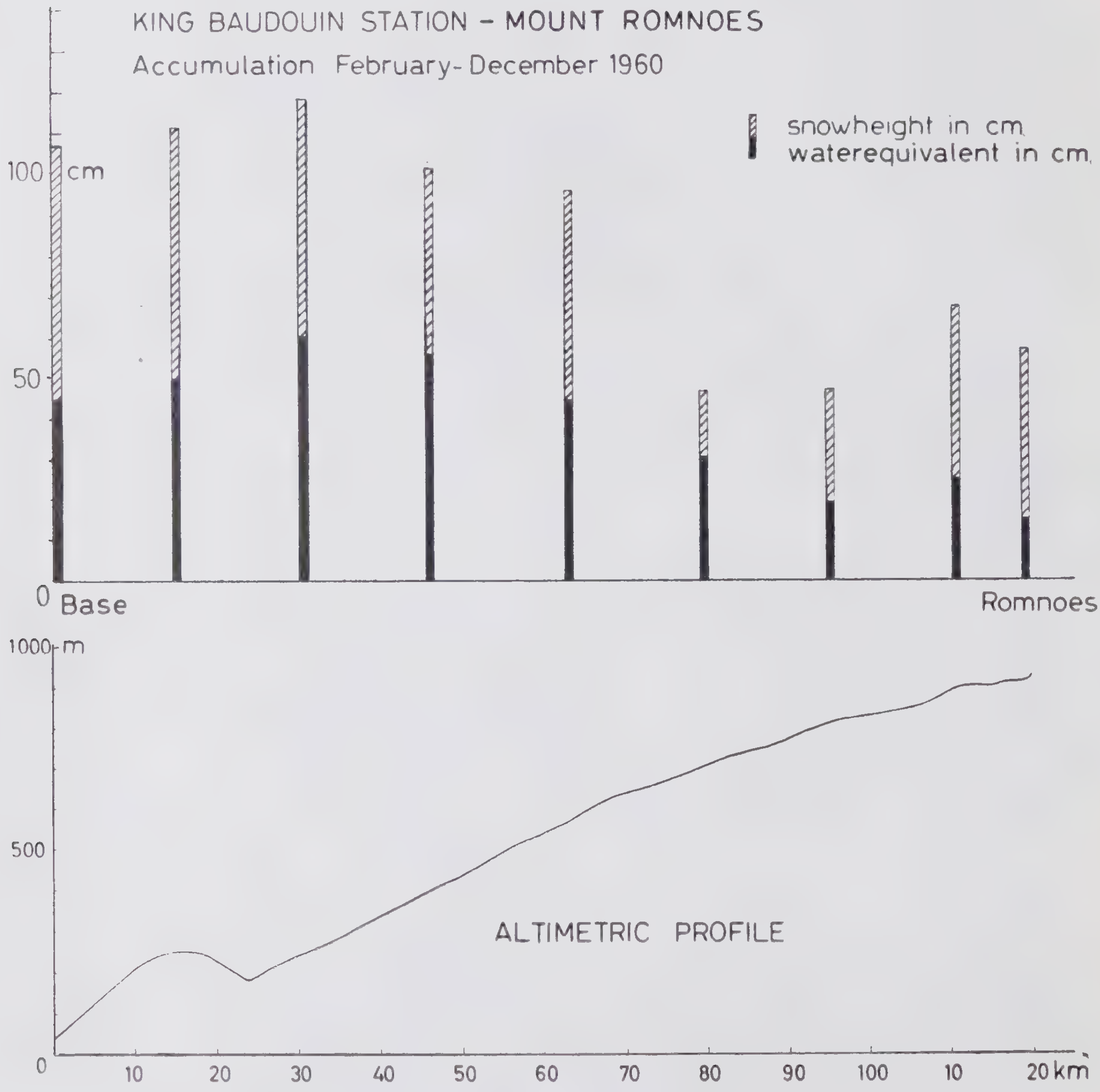

Fig. 5. North-South accumulation profile from the Station to Mount Romnoes. The altimetric profile is based on barometric levelling by J. Loodts (1960).

Profil nord-sud d'accumulation de la base au Mont Romnoes. Le profil altimétrique a été dressé par nivellement barométrique (J. Loodts, 1960).

Noord-zuid akkumulatieprofiel van de basis tot Romnoesberg. Het altimetrisch profiel werd opgenomen volgens barometrische hoogtemeting door J. Loodts (1960).

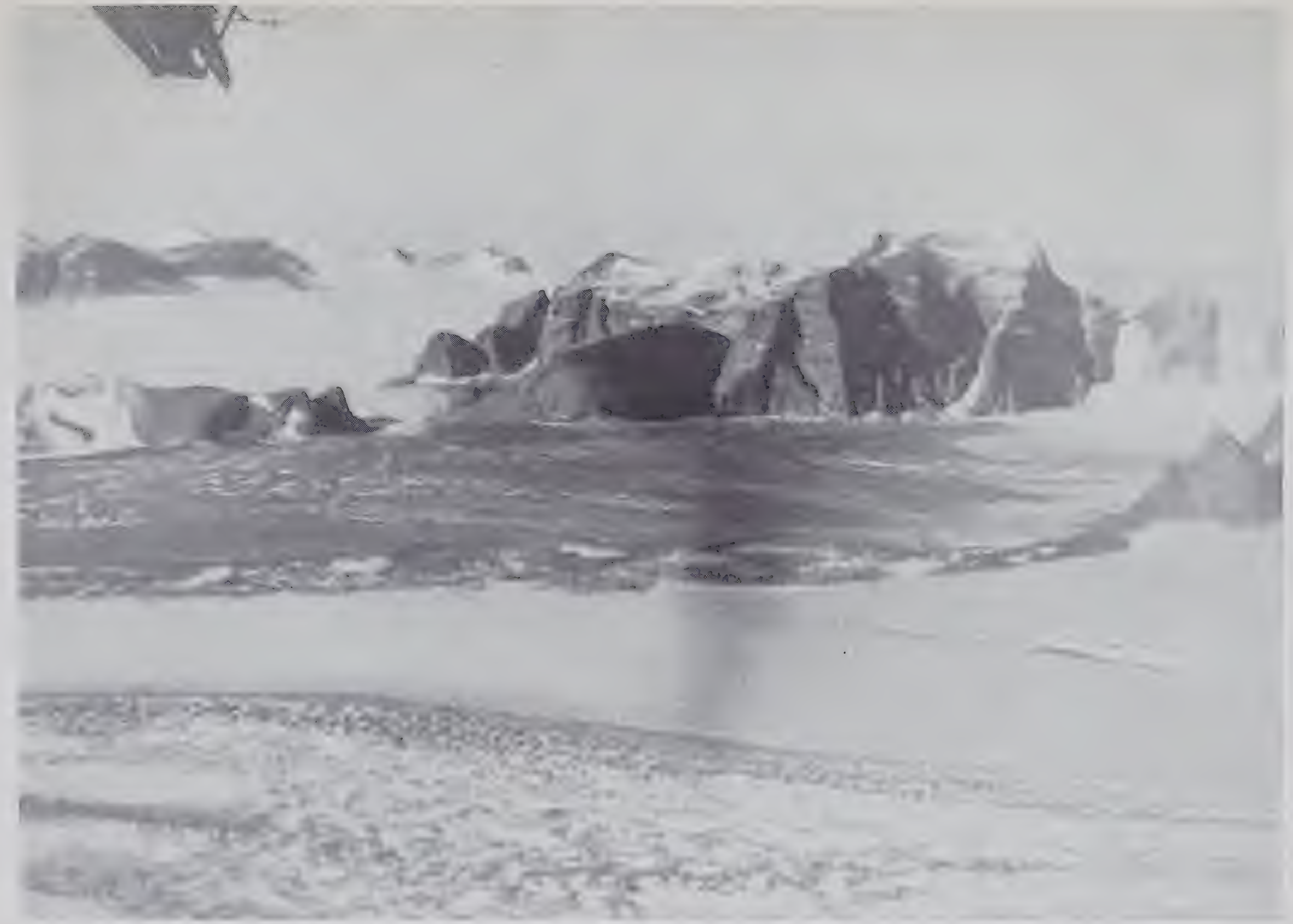

Photo 5 (L. Goossens)

Queen Fabiola Mountains. This 60 km long range is situated between 71°10’ S and 71°40’ S and between 35° E and 36° E.

Les Monts Reine Fabiola. Cette chaîne d’une longueur de 60 km est située entre 71°10’ S et 71°40’ S et entre 35° E et 36° E.

De Koningin-Fabiolabergen. Deze 60 km lange keten is gelegen tussen 71°10’ S en 71°40’ S en tussen 35° E en 36° E.

Region east of Sör-Rondane Mountains

During some flights the so-called „Lake District" was flown over. On the aerial photographs of the Highjump Operation in 1947 glare ice spots seemed to be linked by a system of small canals. However no sign of running meltwater has been observed in 1960.

The glare ice spots which have been flown over, occur on the north-easterly side of smooth undulations. They are intensely crevassed. A few ice samples have been taken. The ice crystals attained a diameter of 10 mm.

During a flight from King Baudouin Station over Trillingane, extreme east point of the Sör-Rondane Mountains, to the Japanese Syowa Station on October the 7th, a heavy crevassed area was observed north of the Belgica Mountains. A mountain range (*), not mentioned on the existing maps, was recorded between 71°10’ S and 71°40’ S and between 35° and 36° E. This 60 km long range is composed of several groups of massifs, the highest attaining almost 2500 m. The surface west of the chain is about 1500 m high. Between the different massifs glaciers descend from the plateau. All of these glaciers are deflected to the north by a heavy push of the ice mass from the South. No other ranges have been observed along this trail although the visibility was about 100 km at an altitude of 3000 m. A Japanese sledge party reached this area in November 1960 (Photo 5).

Acknowledgements

The author acknowledges assistance received from all the members of the expedition and the summer parties, especially K. Blaiklock, G. Derom, leader, M. Foccroulle, J. Giot, L. Goossens, E. Picciotto and J. Verheye, Thanks are also extended to the CNRPB (Centre National de Recherches Polaires de Belgique), the IGM (Institut Géographique Militaire), the University of Ghent and the SLF (Eidg. Institut für Schnee- und Lawinenforschung) on the Weissfluhjoch, Davos, Switzerland.

The complete report of the glaciological activities of the third Belgian Antarctic Expedition will be published in 1962. In the mean time the author is willing to give all information required.

(*) The name „Queen Fabiola Mountains" has been proposed for this new range.

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RÉSUMÉ

En 1960 des études glaciologiques ont été effectuées à la Base Roi Baudouin (70°26' S - 24°19' E), sur l'ice shelf de la Côte de la Princesse Ragnhild, et au cours des excursions dans l'avant-pays continental et dans la chaîne des Sör-Rondane. Des échantillons de glace et de neige ont été prélevés dans ces différentes régions, en vue d'analyses isotopiques et chimiques à exécuter en Belgique.

A la base, l'accumulation et la résistance au battage étaient relevées mensuellement. On a tenté de mesurer l'accumulation due au chasse-neige, aux abords d'obstacles. La stratigraphie du névé a été réalisée sur un profil vertical de 16 m. Pendant le mois de janvier 1961, le groupe glaciologique de la campagne d'été 1961, commandé par le Dr. E. PICCIOTTO a réussi un sondage dans l'ice shelf atteignant 115,7 m.

Durant les excursions d'été en novembre et décembre 1960 des puits d'environ 1 m de profondeur ont été creusés, destinés à des études de température, de densité et de stratigraphie. Des balises en bambou, plantée en février et mars 1960 ont permis de mesurer l'accumulation totale pour 1960.

SAMENVATTING

De Koning-Boudewijnbasis (70°26' S - 24°19' E, J. LOODTS, 1960) werd opgericht in december 1957 op de „ice shelf" van de Prinses-Ragnhild-kust, op ongeveer 12 km van de open zee (Fig. 1). Drie achtereenvolgende expedities hebben er overwinterd.

In hetgeen volgt, worden de glaciologische waarnemingen in 1960 nabij de basis, en tijdens de sledetochten in de Sör-Rondanebergen en het gebied tussen de bergen en de basis beschreven. Een aantal sneeuw-, firn- en ijsstalen werden, met het oog op een uitgebreid chemisch en isotopisch onderzoek, naar België overgebracht.

AKKUMULATIE EN DICHTHEID

Maandelijks werd de hoogte van het sneeuwdek op bakens afgelezen. De bakens, 25 in het totaal, waren geplaatst buiten de invloedzone van de basis. De sneeuwhoogten van april 1960 tot januari 1961 worden aangegeven in Fig. 2.

Voor het ganse jaar 1960 bedraagt de akkumulatie 45,5 cm water. Dit cijfer ligt enigszins hoger dan het gemiddelde van de laatste zes jaar, dat schommelt rond 40 cm.

Fig. 3 geeft een stratigrafisch profiel, opgenomen op 31 december 1960, weer. Ramweerstanden werden eveneens om de maand gemeten.

SNEEUWDRIFTAKKUMULATIE

Ten einde de akkumulatie, veroorzaakt door hindernissen, na te gaan, werden panelen (50 cm × 50 cm en 25 cm × 25 cm) loodrecht op de richting van de overheersende winden geplaatst. Het opdriften vóór de hindernis beperkt zich tot enkele meters, terwijl aan de lijzijde de driftruggen zich enkele tientallen meters ver uitstrekken.

DIEPERE WAARNEMINGEN

Een put van ongeveer 16 m diepte verleende toegang tot de diepere firnlagen. De volledige stratigrafie van 1938 tot 1957 kon aldus worden opgetekend. Het afbakenen van de jaargrenzen berust hoofdzakelijk op de afwisseling van grofkorrelige zomerlagen en fijnkorrelige winterafzettingen (W. SCHYTT, 1958).

De lagen tussen 6 en 9 meter diepte, overeenstemmend met de periode 1945-1949 worden gekenmerkt door een zeer intense ijsvorming. Het is moeilijk de jaarlijkse akkumulatie te onderscheiden, daar fijnkorrelige afzettingen ontbreken.

Dichtheidsmetingen werden uitgevoerd met Sipre handboor. De diepte-dichtheidskurve (Fig. 4) verloopt analoog met degene, die door vroegere expedities werden gevonden (Maudheim, Little America V, Byrd). Hierbij moet rekening worden gehouden met het feit dat het nulniveau zich op ongeveer 4 m onder het sneeuwoppervlak bevond.

De temperatuurmetingen zijn onnauwkeurig wegens de nabijheid van de basis.

DIEPE BORING

Een diepe boring werd met succes uitgevoerd door de zomerploeg 1961 onder de leiding van Dr. E. PICCIOTTO. Een diepte van 115,70 m werd bereikt. Stratigrafie en densiteit tot 43 m werden ter plaatse nagegaan. Een uitgebreide, isotopische en glaciologische studie van de boorkernen, die bewaard worden te Brussel aan —17°C, is voorzien.

HET GEBIED TUSSEN DE BASIS EN HET GEBERGTE

Op het kontinentaal voorland werd de akkumulatie gemeten langs een noord-zuid gerichte lijn van de basis tot de Romnoesberg op 120 km. Uit de metingen van de acht bakenstations, op het einde van 1960, bleek een afname van de akkumulatie naar het zuiden toe (Fig. 5). Ramweerstand, temperatuur, dichtheid en stratigrafie werden opgenomen.

DE SÖR-RONDANEBERGEN

Op de Gillock-, de Ellis-, de Jennings- en de Gjelgletsjer werden in februari en maart akkumulatiebakens geplaatst. In nobember 1960 werd op de Gillock- en de Ellisgletsjer een algemene ablatie vastgesteld. Alleen de westzijde vertoonde akkumulatie, veroorzaakt door de oostelijke winden. Op de Jenningsgletsjer werd, ter hoogte van Brattnipane, een akkumulatie van 10 cm sneeuw waargenomen. Op de Gjelgletsjer bedroeg de gemiddelde akkumulatie 45 cm sneeuw. Overal hadden de naakte-ijszones zich uitgebreid.

K. BLAIKLOCK, topograaf van de expeditie, nam de beweging van sommige gletsjers waar.

HET GEBIED TEN OOSTEN VAN DE SÖR-RONDANEBERGEN

In het zgn. „Lake District" was geen spoor van smeltwater te bespeuren. De zones met onbedekt ijs in dit gebied komen voor op de noordoostelijke zijde van terreingolvingen.

Gedurende een vlucht van de Belgische naar de Japanse basis over de Sör-Rondanebergen werd een onvermelde bergketen gelokalizeerd tussen 71°10' S en 71°40' S en tussen 35° E en 36° E. Deze 60 km lange keten bestaat uit een zevental massieven, waartussen gletsjers afdalen naar het lagergelegen westelijk gebied (1500 m). De gletsjers worden naar het noorden afgebogen onder de druk van uit het zuiden komende ijsmassa's. Het hoogste punt bereikt 2.500 m.

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